U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: Change 14 to STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS

Date: 11/26/04
Initiated by: AAS-100

AC No: 150/5370-10A
Change: 14

1. PURPOSE. ITEM P-620 RUNWAY AND TAXIWAY PAINTING has been revised to add another option for reflective glass beads and to improve the paragraphs related to surface preparation. Item F-162 CHAIN-LINK FENCES has been revised to clarify post, rail, and brace requirements under ASTM F 1083 or ASTM F-1043.

2. PRINCIPAL CHANGES. The following principal changes have been made:

a. Paragraph 620-2.3 has been revised to add new bead type and gradations.

b. Table 1, paragraph 620-3.5 has been revised to include paint and bead application rates for Type IV beads. Paragraph 620-2.2a WATERBORNE has been revised to indicate that paint shall meet the requirements of TT-P-1952D.

c. ASTM D 1213-54(1975) Test Method for Crushing Resistance of Glass Spheres has been added to the Testing Requirements for Item P-620.

d AASHTO M 247 (2001) Glass Beads Used in Traffic Paints has been added to the Testing Requirements for Item P-620.

e. The use of drop-on silica sand in markings has been deleted from Item P-620.

f. Paragraph F-162 2.3 has been clarified to include ASTM F 1043 and ASTM F 1083 materials.

The change number and date are shown at the top of each page.

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ORIGINAL SIGNED BY

JAMES R. WHITE

FOR

DAVID L. BENNETT
Director, Office of Airport Safety and Standards

ITEM P-620 RUNWAY AND TAXIWAY PAINTING

DESCRIPTION

620-1.1 This item shall consist of the painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Engineer.

MATERIALS

620-2.1 MATERIALS ACCEPTANCE. The Contractor shall furnish manufacturer's certified test reports for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. The reports can be used for material acceptance or the Engineer may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the Engineer upon arrival of a shipment of materials to the site.

620-2.2 PAINT. Paint shall be **[Waterborne, Epoxy, Methacrylate, or Solvent-base]** in accordance with the requirements of paragraph 620-2.2**[ ]**. Paint shall be furnished in **[ ]** in accordance with Federal Standard No 595.

* *

The Engineer shall specify paint type(s) and appropriate paragraph number(s). The Engineer shall insert the colors to be used on a project from the following list:

White - 37925
Yellow - 33538 or 33655
Pink - 1 part Red - 31136 to 2 parts White - 37925
Red - 31136
Black - 37038

Waterborne or solvent base black paint should be used to outline a border at least 6 inches (150 mm) wide around markings on all light colored pavements.

For TT-P-1952D and A-A-2886A paints, the Engineer shall specify the type required.
Type I is intended for those locations where slower tracking is not an inconvenience.
Type II is intended for striping locations where faster curing is desirable.
Type III (A-A-2886A only) - Premixed Reflectorized, Standard Dry for temporary markings.

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a. WATERBORNE. Paint shall meet the requirements of Federal Specification TT-P-1952D,**[Type I or Type II]**.

b. EPOXY. Paint shall be a two component, minimum 99 percent solids type system conforming to the following:

(1) Pigments. Component A. Percent by weight.

(a) White:
Titanium Dioxide, ASTM D 476, type II shall be 18 percent minimum (16.5 percent minimum at 100 percent purity).

(b) Yellow and Colors:
Titanium Dioxide, ASTM D 476, type II shall be 14 to 17 percent.
Organic yellow, other colors, and tinting as required to meet color standard.
Epoxy resin shall be 75 to 79 percent.

(2) Epoxy Content. Component A. The weight per epoxy equivalent, when tested in accordance with ASTM D 1652 shall be the manufacturer's target plus or minus 50.

(3) Amine Number. Component B. When tested in accordance with ASTM D 2074 shall be the manufacturer's target plus or minus 50.

(4) Prohibited Materials. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen, as defined in 29 CFR 1910.1200.

(5) Daylight Directional Reflectance:

(a) White: The daylight directional reflectance of the white paint shall not be less than 75 percent (relative to magnesium oxide), when tested in accordance with Federal Test Method Standard No. 141, Method 6121.

(b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 38 percent (relative to magnesium oxide), when tested in accordance with Federal Test Method Standard No. 141. The x and y values shall be consistent with the Federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x .462	x .470	x .479	x .501
y .438	y .455	y .428	y .452

(6) Accelerated Weathering.

(a) Sample Preparation. Apply the paint at a wet film thickness of 0.013 inch (0.33 mm) to four 3 by 6 inch (8 by 15 cm) aluminum panels prepared as described in Federal Test Method Standard No. 141, Method 2013. Air dry the sample 48 hours under standard conditions.

(b) Testing Conditions. Test in accordance with ASTM G 53 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating 4 hour UV exposure at 60 degree C, and 4 hours condensate exposure at 40 degrees C.

(c) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 620-2.2b(5) above. Evaluate for conformance with the color requirements.

(7) Volatile Organic Content. Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

(8) Dry Opacity. Use Procedure B, Method B of Method 4121 of Federal Test Method Standard No. 141. The wet film thickness shall be 0.015 inch (0.12 mm). The minimum opacity for white and colors shall be 0.92.

(9) Abrasion Resistance. Subject the panels prepared in paragraph 620-2.2b(6) to the abrasion test in accordance with ASTM D 968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters of unused sand shall be used for each test panel. The test shall be run on two test panels. [Note: five liters of sand weighs 17.5 lb. (7.94 kg).] Both baked and weathered paint films shall require not less than 150 liters of sand for the removal of the paint films.

(10) Hardness, Shore. Hardness shall be at least 80 when tested in accordance with ASTM D 2240.

c. METHACRYLATE. Paint shall be a two component, minimum 99 percent solids-type system conforming to the following:

(1) Pigments. Component A. Percent by weight.

(a) White:

Titanium Dioxide, ASTM D 476, type II shall be 6 percent minimum.
Methacrylate resin shall be 18 percent minimum.

(b) Yellow and Colors:

Titanium Dioxide, ASTM D 476, type II shall be 6 percent minimum.

Organic yellow, other colors, and tinting as required to meet color standard. Methacrylate resin shall be 18 percent minimum.

(2) Prohibited Materials. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen, as defined in 29 CFR 1910.1200.

(3) Daylight Directional Reflectance:

(a) White: The daylight directional reflectance of the white paint shall not be less than 80 percent (relative to magnesium oxide), when tested in accordance with Federal Test Method Standard No. 141, Method 6121.

(b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 55 percent (relative to magnesium oxide), when tested in accordance with Federal Test Method Standard No. 141. The x and y values shall be consistent with the Federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x .462	x .470	x .479	x .501
y .438	y .455	y .428	y .452

(4) Accelerated Weathering.

(a) Sample Preparation. Apply the paint at a wet film thickness of 0.013 inch (0.33 mm) to four 3 by 6 inch (8 by 15 cm) aluminum panels prepared as described in Method 2013 of Federal Test Method Standard No. 141. Air dry the sample 48 hours under standard conditions.

(b) Testing Conditions. Test in accordance with ASTM G 53 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating 4 hour UV exposure at 60 degree C, and 4 hours condensate exposure at 40 degrees C.

(c) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 620-2.2c(3) above. Evaluate for conformance with the color requirements.

(5) Volatile Organic Content. Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

(6) Dry Opacity. Use Procedure B, Method B of Method 4121 of Federal Test Method Standard No. 141. The wet film thickness shall be 0.015 inch (0.12 mm). The minimum opacity for white and colors shall be 0.92.

(7) Abrasion Resistance. Subject the panels prepared in paragraph 620-2.2c(4) to the abrasion test in accordance with ASTM D 968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters of unused sand shall be used for each test panel. The test shall be run on two test panels. [Note: five liters of sand weighs 17.5 lb. (7.94 kg).] Both baked and weathered paint films shall require not less than 150 liters of sand for the removal of the paint films.

(8) Hardness, Shore. Hardness shall be at least 80 when tested in accordance with ASTM D 2240.

d. SOLVENT-BASE. Paint shall meet the requirements of Federal Specification **[A-A-2886A Type I or Type II]**.

620-2.3 REFLECTIVE MEDIA. Glass beads shall meet the requirements for **[ ]**. Glass beads shall be treated with adhesion promoting and/or flotation coatings as specified by the manufacturer.

* *

The Engineer should insert all that will be used in the project. When more than one bead type is specified, the plans should indicate the bead type for each marking.
[Federal Specification. TT-B-1325C, Type I, gradation A]
[Federal Specification. TT-B-1325C, Type III]
[TYPE IV]

The Engineer should consult with the paint and bead manufacturer on the use of adhesion, flow promoting, and/or flotation additives.

When Type IV beads are specified, the following shall be included.

Type IV glass beads shall meet the requirements of AASHTO M 247 and the following:

Characteristic	Test Method	Requirement
Roundness, beads passing U.S. Sieve Size No. 20	ASTM-1155	85 percent, minimum
Roundness, beads retained U.S. Sieve Size No. 20	Beads shall be judged optically by the percent having an aspect ratio of less than 1.2	85 percent, minimum
Index of Refraction	TT-B-1325C	1.50 minimum
Specific Gravity	TT-B-1325C	2.30 minimum
Crushing Strength	ASTM D 1213	40,000 psi minimum

Gradation

U.S. Sieve No.	Microns	Type IV-A Minimum percent passing by weight	Type IV-A Maximum percent passing by weight	Type IV-B Minimum percent passing by weight	Type IV-B Maximum percent passing by weight
12	1700	100	--	100	--
14	1400	95	100	--	--
16	1180	80	95	95	100
18	1000	10	40	--	--
20	850	0	5	35	70
25	710	--	--	--	--
30	600	--	--	0	5
PAN					

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CONSTRUCTION METHODS

620-3.1 WEATHER LIMITATIONS. The painting shall be performed only when the surface is dry and when the surface temperature is at least 45 degrees F (7 degrees C) and rising and the pavement surface temperature is at least 5 degrees F (2.7 degrees C) above the dew point. **[Painting operations shall be discontinued when the surface temperature exceeds [ ] degrees F ([ ] degrees C.]**

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The Engineer may specify minimum and maximum surface temperatures based on paint manufacturer's recommendations.

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620-3.2 EQUIPMENT. Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type marking machine suitable for application of traffic paint. It shall produce an even and uniform film thickness at the required coverage and shall apply markings of uniform cross sections and clear-cut edges without running or spattering and without over spray.

620-3.3 PREPARATION OF SURFACE. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material that would reduce the bond between the paint and the pavement. The area to be painted shall be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials. **[Paint shall not be applied to Portland cement concrete pavement until the areas to be painted are clean of curing material. Sandblasting or high-pressure water shall be used to remove curing materials.]**

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The Engineer should specify any additional surface preparation required and should specify the type of surface preparation to be used when existing markings interfere with or would cause adhesion problems with new markings.

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620-3.4 LAYOUT OF MARKINGS. The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans**.**

*** ***

Glass beads improve conspicuity and the friction characteristics of markings. When markings are part of an AIP or PFC funded project, at a minimum, the Engineer shall indicate the following locations to receive glass beads:

1. **All runway and taxiway holding position markings.**
2. **Runway threshhold marking.**
3. **Runway threshhold bar.**
4. **Runway aiming point marking.**
5. **Runway designation marking.**
6. **Runway touchdown zone markings.**
7. **Runway centerline marking.**
8. **Taxiway centerline marking.**
9. **Geographical position marking.**
10. **Surface painted signs.**

In addition to the minimum list above, the following locations are recommended to receive glass beads:

11. **Runway side stripes,**
12. **Taxiway edge markings,**
13. **Non-movement Area boundary markings,**
14. **Displaced threshold markings, and**
15. **Demarcation bar.**

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620-3.5 APPLICATION. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the Engineer.
The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m) and marking dimensions and spacings shall be within the following tolerances:

Dimension and Spacing	Tolerance
36 inches (910 mm) or less	+/- 1/2 inch (12 mm)
greater than 36 inches to 6 feet (910 mm to 1.85 m)	+/- 1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	+/- 2 inches (51 mm)
greater than 60 feet (18.3 m)	+/- 3 inches (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate(s) shown in Table 1. The addition of thinner will not be permitted. A period of **[ ]** shall elapse between placement of a bituminous surface course or seal coat and application of the paint.

TABLE 1. APPLICATION RATES FOR PAINT AND GLASS BEADS

Paint Type	Paint Square feet per gallon, ft^2/gal (Square meters per liter, m^2/l)	Glass Beads, Type I, Gradation A Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)	Glass Beads, Type III Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)	Glass Beads, Type IV Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)
*	*	*	*	*

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The Engineer shall specify the application rates for paint and glass beads from the following table.

APPLICATION RATES FOR PAINT AND GLASS BEADS FOR TABLE 1

Paint Type	Paint Square feet per gallon, ft^2/gal (Square meters per liter, m^2/l)	Glass Beads, Type I, Gradation A Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)	Glass Beads, Type III Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)	Glass Beads, Type IV Pounds per gallon of paint--lb./gal. (Kilograms per liter of paint--kg/l)
Waterborne	115 ft^2/gal. Maximum (2.8 m^2/l)	7 lb./gal. Minimum (0.85 kg/l)	12 lb./gal. Minimum (1.45 kg/l)	--
Waterborne	90 ft^2/gal. Maximum (2.2 m^2/l)	--	--	8 lb./gal. Minimum (1.0 kg/l)
Solvent Base	115 ft^2/gal. Maximum (2.8 m^2/l)	7 lb./gal. Minimum (0.85 kg/l)	12 lb./gal. Minimum (1.45 kg/l)	--
Solvent Base	90 ft^2/gal. Maximum (2.2 m^2/l)	--	--	8 lb./gal. Minimum (1.0 kg/l)
Epoxy	90 ft^2/gal. Maximum (2.2 m^2/l)	15 lb./gal. Minimum (1.8 kg/l)	24 lb./gal. Minimum (2.9 kg/l)	16 lb./gal. Minimum (1.9 kg/l)
Methacrylate	45 ft^2/gal. Maximum (1.1 m^2/l)	15 lb./gal. Minimum (1.8 kg/l)	24 lb./gal. Minimum (2.9 kg/l)	16 lb./gal. Minimum (1.9 kg/l)

The Engineer shall specify the time period in order to allow adequate curing of the pavement surface. The Engineer should contact the paint manufacturer to determine the wait period.

Due to the increased surface area to cover, the following should be substituted when painting P-402 Porous Friction Course with waterborne or solvent based paints: "The paint shall be mixed in

accordance with the manufacturer's instructions and applied to the pavement with a marking machine from two directions at 75 percent of the rate(s) (e.g. rate/0.75 for paint, 0.75×rate for beads) shown in Table 1 from each direction."

Markings may be required before paving operations are complete. The Engineer may wish to specify waterborne or solvent-based materials for temporary markings at 30-50 percent of the specified application rates (e.g. rate/0.50). No glass beads are required for temporary markings. A-A-2886A, Type III may be used for temporary markings when reflectorized temporary markings are desired

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Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished which is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate(s) shown in Table 1. Glass beads shall not be applied to black paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made.

All emptied containers shall be returned to the paint storage area for checking by the Engineer. The containers shall not be removed from the airport or destroyed until authorized by the Engineer.

620-3.6 PROTECTION. After application of the paint, all markings shall be protected from damage until the paint is dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings of paint.

METHOD OF MEASUREMENT

620-4.1 The quantity of runway and taxiway markings to be paid for shall be **[the number of square feet (square meters) of painting and the number of pounds (kilograms) of reflective media] [one complete item in place]** performed in accordance with the specifications and accepted by the Engineer.

BASIS OF PAYMENT

620-5.1 Payment shall be made at the respective contract **[price per square foot (square meter)] [lump sum price]** for runway and taxiway painting and **[price per pound (kilogram)] [lump sum price]** for reflective media**.** This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-620-5.1-1 Runway and Taxiway Painting
[per square foot (square meter)] [lump sum]

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The Engineer should include a pay item for each paint and bead type material specified.

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Item P-620-5.1-2 Reflective Media **[per pound (kilogram)] [lump sum]**

TESTING REQUIREMENTS

ASTM C 371	Wire-Cloth Sieve Analysis of Nonplastic Ceramic Powders
ASTM D 92	Test Method for Flash and Fire Points by Cleveland Open Cup
ASTM D 711	No-Pick-Up Time of Traffic Paint

ASTM D 968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1213-54(1975)	Test Method for Crushing Resistance of Glass Spheres
ASTM D 1652	Test Method for Epoxy Content of Epoxy Resins
ASTM D 2074	Test Method for Total Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D 2240	Test Method for Rubber Products-Durometer Hardness
ASTM G 53	Operating Light and Water-Exposure Apparatus (Florescent UV-Condensation Type) for Exposure of Nonmetallic Materials.

Federal Test Method Standard No. 141	Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing

MATERIAL REQUIREMENTS

ASTM D 476	Specifications for Titanium Dioxide Pigments
Code of Federal Regulations	40 CFR Part 60, Appendix A 29 CFR Part 1910.1200
Fed. Spec. TT-B-1325C	Beads (Glass Spheres) Retroreflective
AASHTO M 247	Glass Beads Used in traffic Paints
Fed. Spec. TT-P-1952D	Paint, Traffic and Airfield Marking, Waterborne
Commercial Item Description (CID) A-A-2886A	Paint, Traffic, Solvent Based
Federal Standard 595	Colors used in Government Procurement

ITEM F-162 CHAIN-LINK FENCES

DESCRIPTION

162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications and the details shown on the plans and in conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

162-2.1 FABRIC. **[The fabric shall be woven with a 9-gauge [galvanized steel wire] [polyvinyl chloride (PVC)-coated steel] [aluminum alloy] [zinc-5% aluminum mischmetal] wire in a 2-inch (50 mm) mesh and shall meet the requirements of [ ].] [The fabric shall be woven from a [ ] gauge aluminum-coated steel wire in a 2-inch (50 mm) mesh and shall conform to the requirements of ASTM A 491.]**

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Galvanized steel fabric shall conform to the requirements of ASTM A 392, Class 2.

Polyvinyl chloride-coated steel shall conform to the requirements of ASTM F 668, Class 2b.

Aluminum alloy fabric shall conform to the requirements of ASTM F 1183.

Zinc-5% aluminum mischmetal alloy coated steel shall conform to the requirements of ASTM F 1345, Class 2.

The Engineer shall specify 9 or 10 gauge aluminum-coated wire.

Metallic-coated fabric shall have a clear acrylic coating applied to the selvage area after weaving.

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162-2.2 BARBED WIRE. Barbed wire shall be 2-strand 12-1/2 gauge **[zinc-coated] [aluminum-coated]** wire with 4-point barbs and shall conform to the requirements of **[ ]**.

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Zinc-coated barbed wire shall conform to the requirements of ASTM A 121, Class 3, Chain Link Fence Grade.

Aluminum-coated barbed wire shall conform to the requirements of ASTM A 585, Class II.

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162-2.3 POSTS, RAILS AND BRACES. Line posts, rails, and braces shall conform to the requirements of ASTM F-1043 or ASTM F 1083 as follows:

[Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.]

[Roll Formed Steel Shapes (C-Sections) shall conform to the requirements of Group IIA, and be galvanized in accordance with the requirements of F 1043, Type A.]

[Hot-Rolled Shapes (H Beams) shall meet the requirements of Group III, and be galvanized in accordance with the requirements of F 1043, Type A.]

[Aluminum Pipe shall conform to the requirements of Group IB.]

[Aluminum Shapes shall conform to the requirements of Group IIB.]

[Vinyl or polyester coated steel shall conform to the requirements of F 1043, Paragraph 7.3 Optional Supplemental Color Coating.]

[Composite posts shall conform to the strength requirements of ASTM F 1043 or ASTM F 1083. The strength loss of composite posts shall not exceed 10 percent when subjected to 3,600 hours of exposure to light and water in accordance with ASTM G 23, ASTM G 26, and ASTM G-53.]

Posts, rails, and braces furnished for use in conjunction with aluminum alloy fabric shall be aluminum alloy or composite .

Posts, rails, and braces, with the exception of galvanized steel conforming to F 1043 or ASTM F 1083, Group 1A, Type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B 117 as follows:

External: 1,000 hours with a maximum of 5% red rust
Internal: 650 hours with a maximum of 5% red rust.

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Fed. Spec. RR-F-191/3D

162-2.4 GATES. Gate frames shall consist of **[galvanized tubular steel pipe] [vinyl or polyester-coated steel pipe] [aluminum alloy pipe] [composite posts]** and shall conform to the specifications for the same material under paragraph 162-2.3. The fabric shall be of the same type material as used in the fence.

162-2.5 WIRE TIES AND TENSION WIRES. Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A 824.

All material shall conform to Fed. Spec. RR-F-191/4D

162-6 MISCELLANEOUS FITTINGS AND HARDWARE. Miscellaneous steel fittings and hardware for use with **[zinc-coated] [aluminum-coated] [zinc-5% aluminum-mischmetal alloy-coated]** steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. **[All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A 153.] [Miscellaneous aluminum fittings for use with aluminum alloy fabric shall be wrought or cast aluminum alloy.]** Barbed wire support arms shall withstand a load of 50 pounds (113 kg) applied vertically to the outermost end of the arm.

162-2.7 CONCRETE. Concrete shall be of a commercial grade with a minimum 28-day compressive strength of 2500 psi (17 240 kPa).

162-2.8 MARKING. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

CONSTRUCTION METHODS

162-3.1 CLEARING FENCE LINE. All trees, brush, stumps, logs, and other debris which would interfere with the proper construction of the fence in the required location shall be removed a minimum width of 2 feet (61 cm) on each side of the fence centerline before starting fencing operations. The cost of removing and disposing of the material shall not constitute a pay item and shall be considered incidental to fence construction.

162-3.2 INSTALLING POSTS. All posts shall be set in concrete at the required dimension and depth and at the spacing shown on the plans.

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Posts should be spaced not more than 10 feet (3 m) apart and should be set a minimum of 36 inches (90 cm) in concrete footings. If the frost depth is greater than 36 inches (90 cm), the posts should be set accordingly. The posts holes shall be in proper alignment so that there is a minimum of 3 inches (75 mm) of concrete on all sides of the posts.

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The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within 7 days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part Portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

162-3.3 INSTALLING TOP RAILS. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

162-3.4 INSTALLING BRACES. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

162-3.5 INSTALLING FABRIC. The wire fabric shall be firmly attached to the posts and braced in the manner shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the contour of the ground, with the bottom of the fence fabric no less than 1 inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Grading shall be performed where necessary to provide a neat appearance.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched thereon to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6 inches (150 mm) or less.

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Openings below the fence may also be spanned with barbed wire fastened to stakes. The Engineer shall specify if tension wire is to be installed.

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162-3.6 ELECTRICAL GROUNDS. Electrical grounds shall be constructed **[where a power line passes over the fence] [at 500-foot (150 m) intervals]**. **[The ground shall be installed directly below the point of crossing.]** The ground shall be accomplished with a copper clad rod 8 feet (240 cm) long and a minimum of 5/8 inch (15 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction.

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The Engineer shall indicate the location of all electrical grounds on the plans. Grounding may not be necessary with the use of composite posts.

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METHOD OF MEASUREMENT

162-4.1 Chain-link fence will be measured for payment by the linear foot (meter). Measurement will be along the top of the fence from center to center of end posts, excluding the length occupied by gate openings.

Gates will be measured as complete units.

BASIS OF PAYMENT

162-5.1 Payment for chain-link fence will be made at the contract unit price per linear foot (meter).

Payment for driveway or walkway gates will be made at the contract unit price for each gate.

The price shall be full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item F-162-5.1	Chain-Link Fence--per linear foot (meter)
Item F-162-5.2	Driveway Gates--per each
Item F-162-5.3	Walkway Gates--per each

MATERIAL REQUIREMENTS

ASTM A 121	Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 123	Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 446	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 491	Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 569	Steel, Carbon (0.15 Maximum, Percent), Hot Rolled Sheet and Strip Commercial Quality
ASTM A 570	Hot-Rolled Carbon Steel Sheet and Strip Structural Quality
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
ASTM A 585	Aluminum-Coated Steel Barbed Wire
ASTM A 824	Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM B 117	Standard Test Method of Salt Spray (Fog) Testing

ASTM B 221	Aluminum-Alloy Extruded Bars, Rods, Wire Shapes and Tubes
ASTM F 668	Poly(vinyl Chloride)(PVC)-Coated Steel Chain-Link Fence
ASTM F 1043	Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
ASTM F 1083	Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1183	Aluminum Alloy Chain Link Fence Fabric
ASTM F 1234	Protective Coatings on Steel Framework for Fences
ASTM G 23	Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 26	Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
Fed. Spec. RR-F-191/3D	Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)
Fed. Spec. RR-F-191/4D	Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)